3. EROSION AND SEDIMENTATION CONTROL BMPS

We are all familiar with at least some chronic erosion problems that are made worse by a high spring water table or a swift moving summer thunder shower. Usually considered little more than an inconvenience, these type of problems have a cumulative effect that, over the years, can have significant environmental impacts, such as loss of aquatic habitat and the accumulation of sediments, resulting in the loss of water depth. Of course, the cost of correcting these problems is more than inconvenient.

In years past, the main concern was getting surface runoff off a site safely. But with our increasing knowledge of the effects of nonpoint source pollution, the problem has become more complicated. Sediment in runoff contains high concentrations of phosphorous, which in lake systems can result in obnoxious algae blooms and loss of cold water fisheries habitat. In estuaries and ocean environments, other pollutants that can be associated with sediment — like bacteria, nitrogen and heavy metals — can close shellfish areas and harm delicate aquatic habitat.

This chapter covers many Best Management Practices (BMPs) that will help control the release of sediment to the aquatic environment and prevent pollution associated with erosion and sedimentation. ***Erosion*** is the loss of soil particles from the ground surface through a force working on the soil's surface, such as wind, water or heavy use. ***Sedimentation*** is the deposition of soil particles onto the soil surface. Erosion control BMPs help to hold the soil particles in place, whereas sedimentation control BMPs are used to filter or settle out soil particles that are already suspended in the water.

There are many erosion and sedimentation control BMPs, and they are covered in full detail in *Maine Erosion Control Handbook for Construction: Best Management Practice*s, available from the DEP. Many of the basic erosion control BMPs, the ones that you should expect to encounter frequently, are covered in lesser detail in this manual. To select the appropriate BMPs, marina operators need to consider their site-specific activities, site layout, and the potential pollution sources.

MULCHING BMPS

Mulch holds down soil particles and prevents them from being washed away by rainfall. There are two types of mulch: temporary and permanent.

Temporary mulch, like hay or straw, is used to help in the establishment of vegetation or to cover bare soil during construction when it is expected that the area will be re-disturbed. ***Permanent mulch*** is used in place of vegetation on bare soil. Examples of permanent mulch include wood chip landscaping around bushes and shrubs where grass will be heavily shaded, or crushed stone on areas that are heavily traveled so that grasses cannot grow.

Temporary Mulch

Areas which have been temporarily or permanently seeded should be mulched immediately following seeding. Areas which cannot be seeded within the growing season should be mulched to provide temporary protection to the soil surface. Mulches are applied to the soil surface to protect the soil and to promote plant growth. A surface mulch is the most effective and quickest means of controlling runoff and erosion on disturbed land. Mulches can regulate the infiltration rate of the soil, conserve soil moisture, prevent soil compaction, modify soil temperatures, and provide a suitable micro-climate for seed germination. **Always mulch new seeding**.

If mulch isn't anchored properly, the soil and seed will wash away. To hold the mulch down, stake biodegradable netting or twine over it, or work the mulch into the soil with a shovel or roller.

Mulch anchoring should be used on slopes greater than 5%, on concentrated flow areas such as diversions and waterway channels, in late fall (past September 15), and over-winter (September 15 - April 15). In sensitive areas (within l00 feet of water resources), temporary mulch must be applied within 7 days or prior to any storm event.

KINDS OF MULCH

Organic Mulches: Organic mulches include hay, straw, shredded corn stalks, wood chips, bark or shavings, sawdust, wood, erosion control mats and wood fiber. The most common mulching material used is hay or straw. Apply mulch hay or straw at a rate of 2 bales per 1,000 square feet. Wet the mulch down with water to hold it in place in flat areas.

Chemical Mulches and Soil Binders: A wide range of synthetic spray-on materials are marketed to protect the soil surface. These are emulsions which are mixed with water and applied to the soil. They may be used alone, but most often are used to hold wood fiber, hydromulches or straw to the soil surface. Apply according to the manufacturer's instructions.

Mats: Mats are manufactured combinations of mulch and netting designed to retain soil moisture, modify soil temperature, and act as a mulch anchor. The most critical aspect of installing mats is obtaining firm continuous contact between the mat and the soil. Install mats in accordance with the manufacturer's recommendations.

Maintenance: All mulches must be inspected periodically, particularly after rainstorms, to check for erosion. If less than 90% of the soil surface is covered by mulch, additional mulch should be applied immediately. Nets must be inspected after rainstorms for dislocation or failure. If the netting is washed out or broken, re-install the net as necessary after repairing any damage to the slope.

Permanent Mulch

Permanent mulch is used in areas where the soil is exposed and vegetation is difficult to establish. This includes high traffic areas around landscaping, paths and walkways that are not paved, and areas that are covered by decking. Permanent mulch reduces runoff and erosion, prevents soil compaction, conserves moisture, helps to establish plant cover, and controls weeds on any area prone to erosion.
Apply plant residues or other suitable materials that resist decomposition (such as wood chips or crushed stone) to the soil surface where it is either impractical or difficult to grow and stabilize vegetation. Wood chips or aggregates should be used on slopes no steeper than 3 to 1 (3 feet horizontally to 1 vertical foot). Regardless of the type of permanent mulch used, it should be applied three or more inches deep in order to adequately control weeds.

KINDS OF MULCH

Wood Chips – Wood chips should be applied at a rate of 500-900 pounds per 1,000 square feet or 10-20 tons per acre. Wood chips should be green or air-dried and free of objectionable coarse materials.

Gravel and Stone – Aggregate cover gravel, crushed stone, or slag should be washed. A ¼ inch to 2½ inch size aggregate should be used at a rate of 9 cubic yards per 1,000 square feet. A plastic filter cloth may be placed between the ground and the stone to prevent the germination of weed seeds or other undesirable vegetation.

Industrial By-Products (Residuals) – Due to the recycling efforts of the state of Maine, an assortment of low cost, environmentally safe industrial by-products are now available. Many of these recycled materials are made from bark and wood waste from the paper making process. This material has performed well in high traffic areas, on steep slopes, and even in areas where runoff flows are expected.

VEGETATIVE COVER

Vegetation holds soil in place and will maintain itself once established. Seeding is used to permanently stabilize the soil, to reduce damage from sediment and runoff, and to enhance the environment. Wherever possible, replanting with native woody species is the best measure. In some cases, where an open area is desirable, lawn or "meadow" grasses may be appropriate.

When seeding a permanent ground cover, use nutrients and pesticides sparingly in order to protect surface and ground water quality. You should also be aware that late fall seeding may fail.

Woody Vegetative Covers

An area can be allowed to revert to or be planted in woody vegetation. Whether as landscaping or as a vegetated buffer, woody vegetative covers confer definite benefits to water quality. Trees, shrubs and brush intercept rainfall before it hits the ground, significantly reducing the chance of erosion. They also absorb more rainfall than lawns, which results in less runoff. In addition, once the trees are established a duff/organic layer is formed from leaf litter, which absorbs and traps many kinds of pollutants associated with stormwater runoff.

The soil between trees and shrubs must be planted with cover vegetation or must be mulched. When establishing ground covers, it is not desirable to plant species that will compete with the ground cover or will make maintenance difficult. A thick durable mulch such as shredded bark or wood chips is recommended to prevent erosion and reduce weed problems.
On slopes where erosion may be a problem, jute netting or erosion control mats may be installed prior to planting, and plants may be tucked into the soil through slits in the netting. Such plants should be put in a staggered pattern to minimize erosion.

SEDIMENT BARRIERS

Sediment barriers are filter fabric fences or lines of hay bales installed to intercept runoff from areas of bare soil. The barrier allows runoff to pass through while trapping the sediment carried by the runoff. They are properly used only for trapping sediment from small disturbed areas having no obvious swales or channels. They must not be installed across ditches, swales, brooks, or streams where concentrated flows will erode the soil around them or collapse them. Do not attempt to use sediment barriers to trap sediment from a large, disturbed area. They work only if you use them within the following limits:

- the drainage area behind the barrier is no more than ¼ acre per 100 feet of barrier,
- the maximum length of slope behind the barrier is no more than 100 feet, and
- the maximum grade behind the barrier is no more than 50% (one 1 foot vertical rise for every 2 horizontal feet).

How to Construct a Sediment Barrier

Construct sediment barriers with either hay bales or synthetic filter fabric (silt fencing). Hay-bale barriers are generally cheaper and easier to install than silt fences. Silt fences, however, generally last longer and trap more sediment than hay-bale barriers.

No matter which type of barrier you use, install it along a slope contour (i.e., straight across the slope so that the barrier is at the same elevation from one end to the other). Otherwise, water will run against the uphill side of the barrier and discharge at its lower end. It is also useful to flair the ends of the barriers slightly uphill to help prevent this problem.

SILT FENCES

Construct a silt fence of standard-strength or extra-strength synthetic fabric following the procedure shown in Figure 1. The fabric must be stapled or wired to the uphill side of the posts and entrenched into the ground. You can avoid having to use a wire backing fence if you use extra-strength fabric and the spacing between support posts is six feet or less. In no case should the post spacing exceed 10 feet or the fence height exceed 3 feet.

HAY BALES

Construct a hay-bale sediment barrier with wire-bound or twine-bound bales of hay following the procedure shown in Figure 2. The bales must be entrenched in the ground. Anchor each bale with at least two stakes driven through the bale. Drive the first stake in each bale toward the previously anchored bale so that the two bales are forced together. Loose hay can be used to fill any gaps between the bales.

Maintaining Sediment Barriers

- Inspect the sediment barriers after each rainfall to ensure that water is not undermining the barrier or running around it. Make any needed repairs immediately.
- If possible, remove accumulated sediment behind the barriers after each storm.
- Remove the sediment barrier when the drainage area behind it has been stabilized. Grade, seed, and mulch any sediment deposits remaining in place after the sediment barrier is removed.

CHECK DAMS

Check dams are small dams constructed across a ditch or swale. They reduce the velocity of flowing water and so reduce soil erosion. Check dams also trap small amounts of sediment behind them; however, they are not a good sediment trapping device and should not be relied on to trap sediment from a severely eroding ditch. They are appropriately used in small ditches or swales which drain 10 acres or less. They must not be used in a natural stream or brook. Specific places in which to install them include the following locations:

- temporary ditches or swales which cannot receive a mesh lining but still need protection;
- permanent ditches or swales which need protection during the establishment of grass linings; and/or
- permanent ditches or swales which cannot be permanently stabilized for an extended period of time.

Constructing Check Dams

Construct check dams from 2- to 3-inch stone. The height of the dam should not exceed 2 feet. The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center of each check dam must be at least 6 inches lower than its outer edges to deter erosion.

Maintaining Check Dams

Inspect the dams frequently to ensure that the center of the dam is lower than its edges. Erosion caused by high flows around the edges of the dam should be repaired immediately. While check dams are not intended to be used for trapping sediment, some sediment will accumulate behind them. Remove the accumulated sediment before it reaches half the original height of the dam.

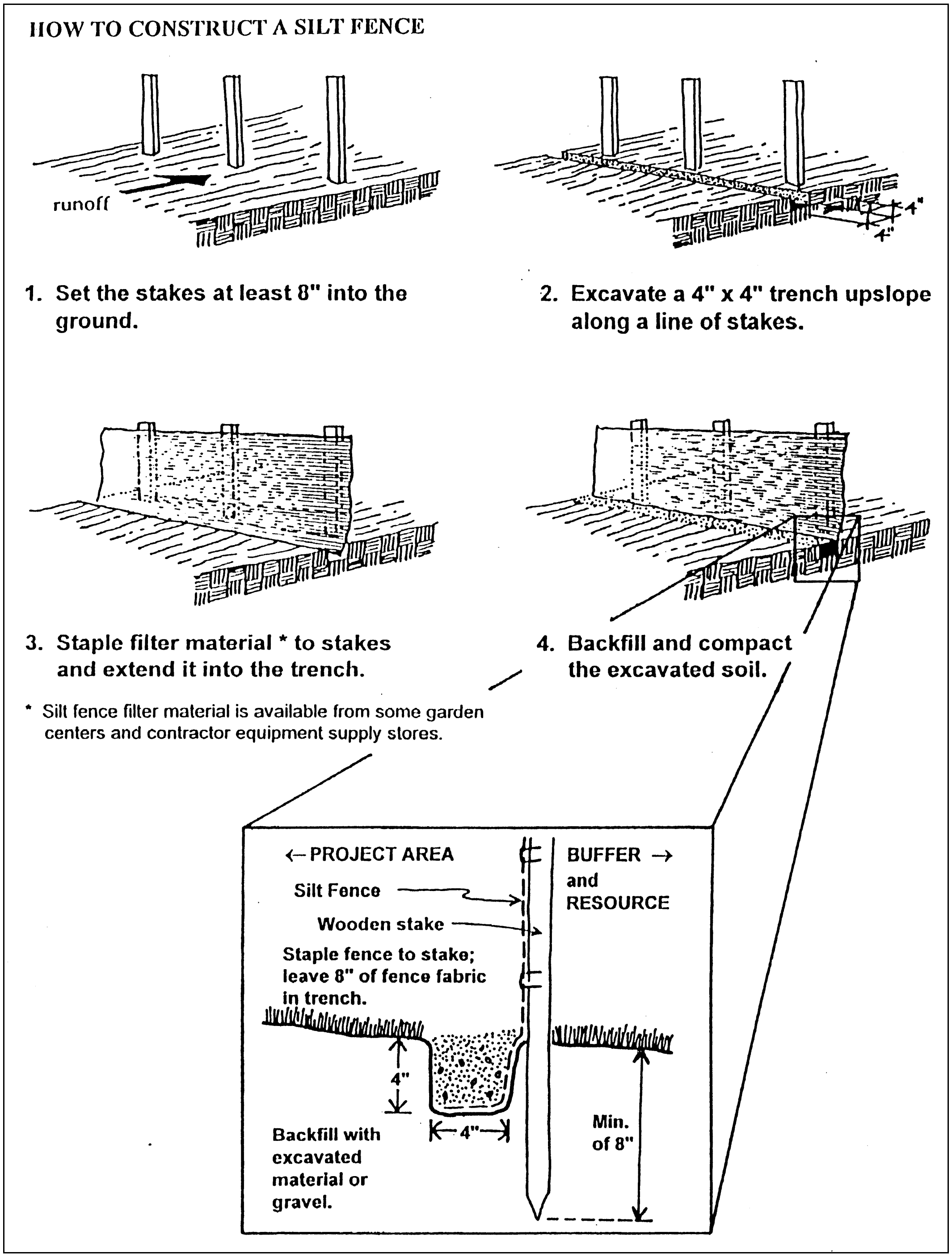
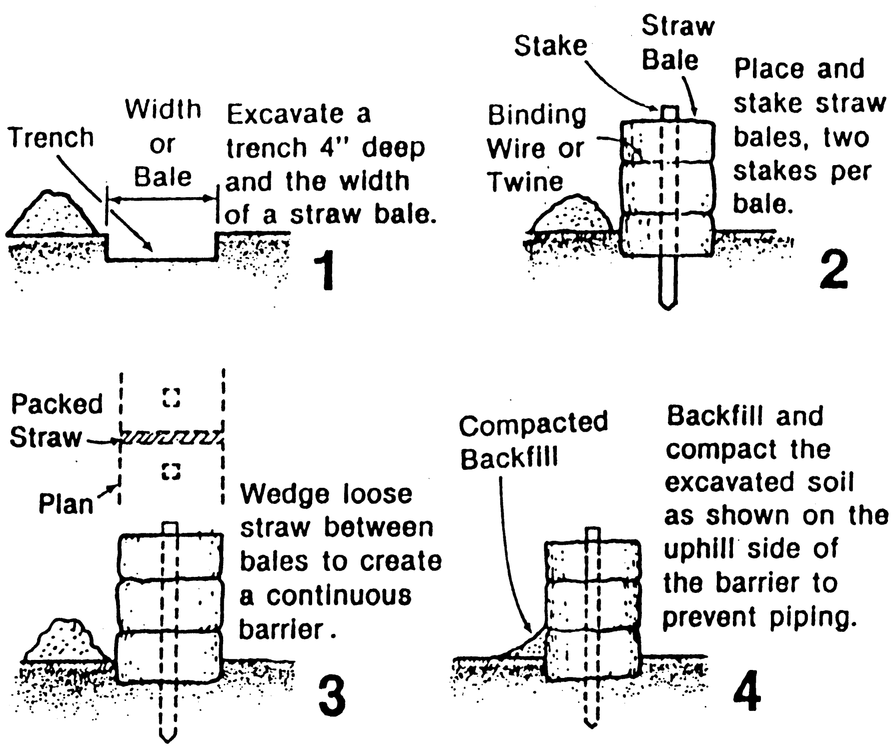
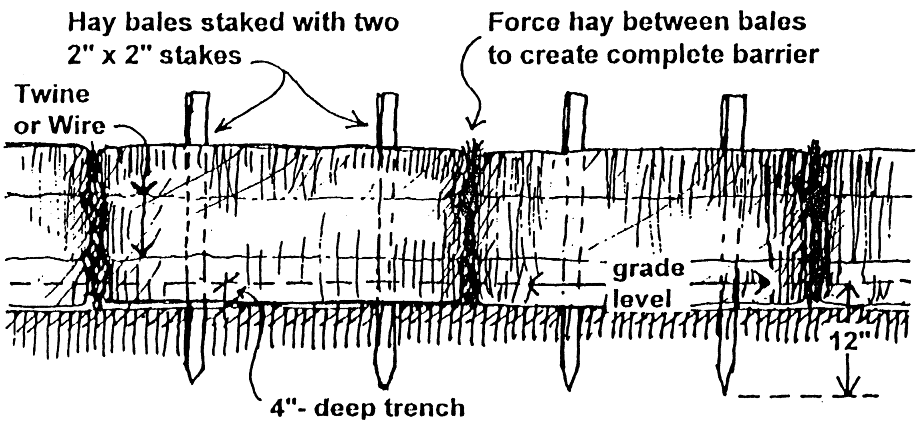


FIGURE 1. SILT FENCE

Construction of Hay-bale Barriers



CONSTRUCTION OF A HAY BALE BARRIER (USDA Soil Conservation Service)



FRONT VIEW OF PROPERLY INSTALLED HAY BALES

FIGURE 2. HAY-BALE BARRIER

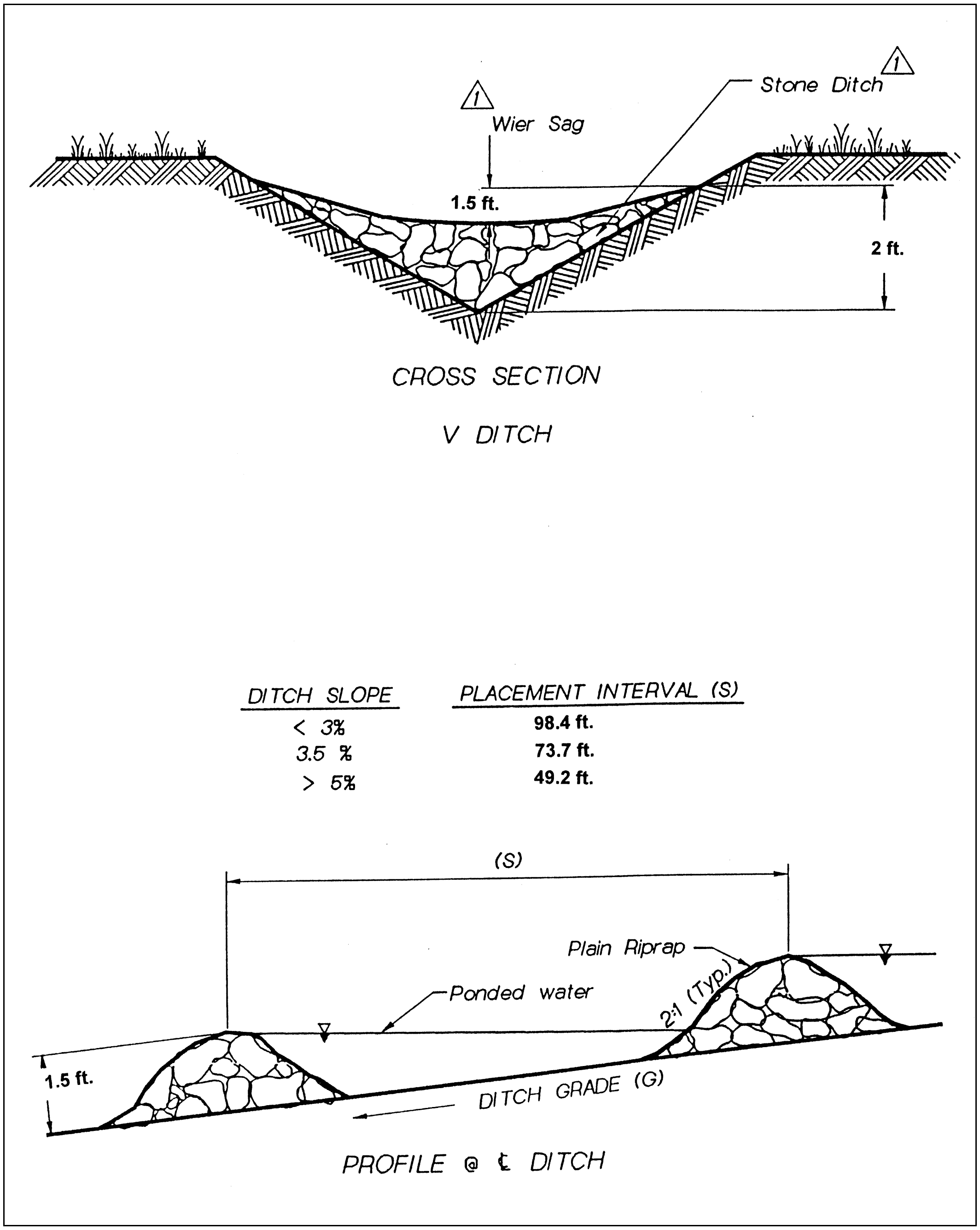


FIGURE 3. STONE CHECK DAM

Removing Check Dams

Check dams are a temporary measure for controlling erosion and must be removed when no longer needed. Remove the check dams once the ditch is stabilized with vegetation or riprap. In the case of a grass-lined ditch, check dams should be removed when the grass has matured sufficiently to protect the ditch. The areas beneath the check dams should be seeded and mulched immediately after the check dams are removed.

DITCH LININGS

Permanent ditch linings are rock or vegetative ground covers used to keep ditches from eroding. The linings protect the soil by binding the soil together and providing an erosion-resistant surface against which the water can flow. Lining a natural stream or brook will require a permit from the Maine Department of Environmental Protection and Army Corps of Engineers.

Should the Lining be Stone or Vegetation?
All linings should be designed or approved by a professional engineer or resource protection agency prior to installation. Large flows, groundwater seepage, and soil conditions can make selection and design of a permanent lining difficult. In general, use a riprap lining instead of a vegetative lining when the following conditions exist:

- the water velocity in the ditch is so great that vegetated linings would fail;
- steep grades, wetness, prolonged base flow, seepage, or piping would cause erosion of vegetated soils;
- people, animals, or vehicles traveling through or across the ditch prevent the establishment of vegetation;
- soils are so highly erodable that vegetation cannot become established; or
- the lining must be installed after the growing season.

Stone Lining

Stone linings are stone ground covers (riprap) used to line the bottom and side slopes of constructed ditches.

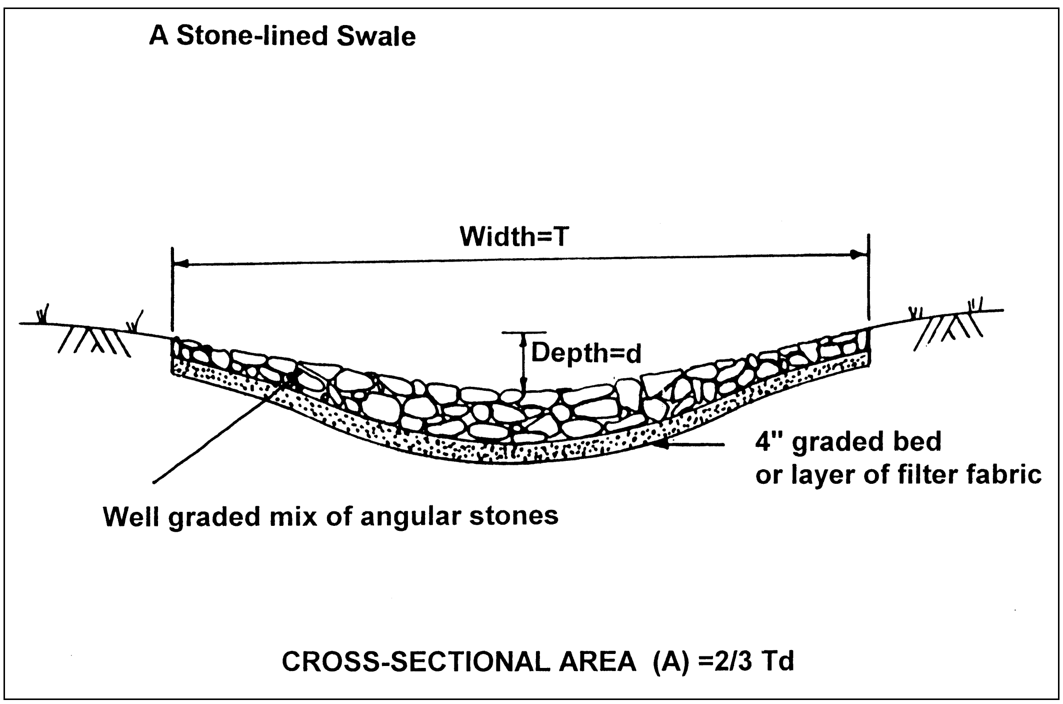


FIGURE 4. STONE-LINED SWALE

Keep the following facts in mind when planning the installation of a riprap lining:

- Use a well-graded mix of durable stone for the lining.
- The stone must be underlain by a filter fabric or a gravel bed to prevent soil loss.
- Remove all trees, stumps, brush, stones, and other debris that will interfere with the placement of riprap in the ditch.

- If possible, compact the surface soils on the ditch bottom and side slopes.
- Place the stone in the ditch using a tractor loader or wheelbarrow. Dumping the stone from a truck will only puncture the filter fabric or tear it away from the side slopes. Major grading of the stone can usually be done with a backhoe. Final grading, however, usually requires hand placement of stones to fill in voids, completely cover any filter fabric, and create a uniform surface.

Maintaining Ditch Linings

VEGETATIVE LININGS

A maintenance program should be established to maintain the ditch's capacity and vegetative cover. The need for periodic liming and fertilizing should be based on soil tests or visual observation. Mow the waterway at least once annually. When practical, delay mowing until after July 15 to accommodate ground nesting wildlife. Mow to a height of 4 to 6 inches to help maintain good surface protection. Do not mow later than 30 days prior to the first anticipated killing frost.

STONE LINING

A maintenance program should be established to maintain ditch capacity and lining integrity. Check the ditch in late spring and fall for slumps and fallen stones. Repair any slumps immediately. Replace stones on areas where the filter fabric is showing through the rocks. Remove any woody vegetation that attempts to grow up through the stones.

SHORELINE STABILIZATION

Shorelines are under constant attack from wave action, fluctuating water levels, tidal currents and boat traffic. Examine your property to determine what forces are at work. Slowly eroding shorelines may be able to be stabilized with vegetation. Otherwise, riprap will be needed.

Stabilizing with Vegetation

Following is a list of some of the variables that will determine if plants will be successful at stabilizing sand dunes or tidal areas. Before deciding to invest your time and money, evaluate your property in terms of the factors below and contact a natural resource agency or plant vendor for guidance on which species to plant.

Fetch: How many miles of open water can wind blow across before reaching your property? This will determine the size of the waves generated. If there are over 5 miles of open water, it is unlikely that vegetation will successfully stabilize your land. Vegetation is most successful where the fetch is less than half a mile.

Shape of Shoreline: Vegetation can hold best in coves. It is most vulnerable on headlands or on straight shoreline areas.

Boat Traffic: The number of boats that travel along the shore and their distance from the shore will influence how well vegetation can grow. The odds of plant survival decrease when more than 10 boats per week travel within half a mile of the shore.

Width of the Beach above Mean High Tide: Beaches greater than 10 feet wide above the mean high tide have the best chances of successful vegetative growth.

Potential Width of Planting Area: The planting area must be greater than 10 feet wide for there to be any reasonable chance of success with vegetation.

Existing Beach Vegetation: The presence of vegetation below the toe of a slope is a favorable indication that planting will be successful.

Stabilizing with Riprap

Riprap is generally only used to stabilize areas eroding due to wave scouring and wave impact. It cannot be relied on alone to stabilize slopes failing due to seepage or soil instability. In these cases, shoreline stabilization may require the installation of groundwater drains, soil reinforcements, or retaining walls. Hire a professional if you have any doubts.

Riprap is composed of three sections: the armor layer, the filter layer, and the toe protection. The typical armor layer is composed of rough, angular rock. The underlying filter layer supports the stone against settlement, allows groundwater to drain through the structure, and prevents the soil beneath from being washed through the armor layer by waves or groundwater seepage. The toe protection prevents movement of the riprap layer into the water. It is usually constructed by trenching in the riprap at the toe of the slope.

Avoid using riprap if vegetation can solve your erosion problem. Vegetation provides habitat for wildlife species and a buffer capable of taking up pollutants and nutrients from runoff. If riprap is unavoidable, then use a combination of riprap and plantings to provide the vegetative cover needed. No riprap can be installed or repaired along the rivers, ponds, lakes, or the ocean without permission from the DEP and Army Corps of Engineers. Contact these agencies if you plan to do any riprap work along any of these locations.

INSTALLING RIPRAP

Selecting a Filter Layer: Filter layers of either special filter cloth or a 6-inch layer of well-graded stone should be provided to prevent the loss of slope material through voids in the armor. If using a filter fabric, hire an engineer to choose an appropriate fabric for your soil conditions. Once the fabric is in place, put a layer of ¾-inch washed stone about 3 inches deep on top of the fabric to help distribute the riprap load and prevent rupture of the filter cloth. If using a stone filter layer, get a clean, well-graded mix containing stone sizes ranging from ¾ of an inch to 3 inches.

Selecting a Stone Size for the Armor Layer: To assure that a riprap shoreline will remain stable, you must specify the size of the stone to be used for the armor layer. Stone size is commonly expressed in terms of a D50 value. D50 values are generally expressed in inches, and can be thought of as the average stone size in a rock mix. For example, if the D50 of a rock mix is 12 inches in diameter, half of the stones will be smaller than 12-inches and half will be larger than 12-inches. The largest stone in the mix should be no larger than 1.5 times the D50. The thickness of the riprap layer should be at least 2 times the D50. Be sure that you get a mixture which includes smaller stone sizes so that small voids in the rock mix can be filled. To find the stone size needed, determine the largest wave height your property is subjected to and use the wave size chart below to find the average stone size for your riprap.

Table 1
RIPRAP SIZING CHART*

Wave Height (ft)	Rock D50 (inches)	Rock Weight (lbs. ea.)
0.5	4	4
1.0	7	13
1.5	8	26
2.0	11	61
2.5	13	105
3.0	16	205
3.5	20	355
4.0	22	490
4.5	26	845
5.0	27	975
5.5	30	1203
6.0	33	1648
6.5	36	2145
7.0	38	2616

* Table is based on a 2:1 slope. Consult an engineer if your slope is steeper.
Assumed stone weight is 155 lbs./cubic foot

Plan to install your riprap when the water level is the lowest. The way in which the riprap is installed makes a big difference. Ideally, machinery should be parked on a flat area at the top of the slope and construction should be done by reaching out over the slope. Unstable slopes, however, may have to be worked from the side or toe to avoid possible slope failure due to the weight of the machinery. Follow the procedure below to install riprap.

Prior to placing the riprap, the existing ground should be graded to an appropriate slope, preferably no steeper than 1.5 horizontal feet to 1 vertical foot (1.5:1). Clean, well-graded fill material should be added as needed to achieve a uniform grade. The fill should be free of large stones (larger than 6 inches) and firmly compacted before construction proceeds.

Dig a trench at the toe of the slope to key in the riprap. The key should be at least three feet deep.

Install the filter layer using proper construction methods for the material. Key-in the filter fabric at the top of the riprap edge and extend the fabric into the toe trench. A stone filter should extend into the toe trench and, if possible, be compacted against the native soil prior to placing the riprap.

Stone placement should start at the toe trench and work upwards. Make sure the armor layer is at least two stones thick and completely covers the fabric or stone filter. An excavator bucket may be used to compact the stone into a solid, interlocking mass. In addition, it may be necessary to place smaller stones by hand in order to get a uniform surface.

MAINTENANCE

Despite its strength, riprap is not maintenance free. Inspect the slope in the spring, in the fall, and after severe storms for slumping, sliding, or seepage problems. Correct any problems immediately. Severe slumping or sliding may indicate that the slope is failing due to forces other than wave impact. Make a careful inspection of the land to the side of the riprap area. Near the riprap edge, erosion may be accelerated by wave reflection from the stone. If this is the case, additional measures may be necessary to halt the erosion. Contact an engineer or your county Soil and Water Conservation District if you have concerns.

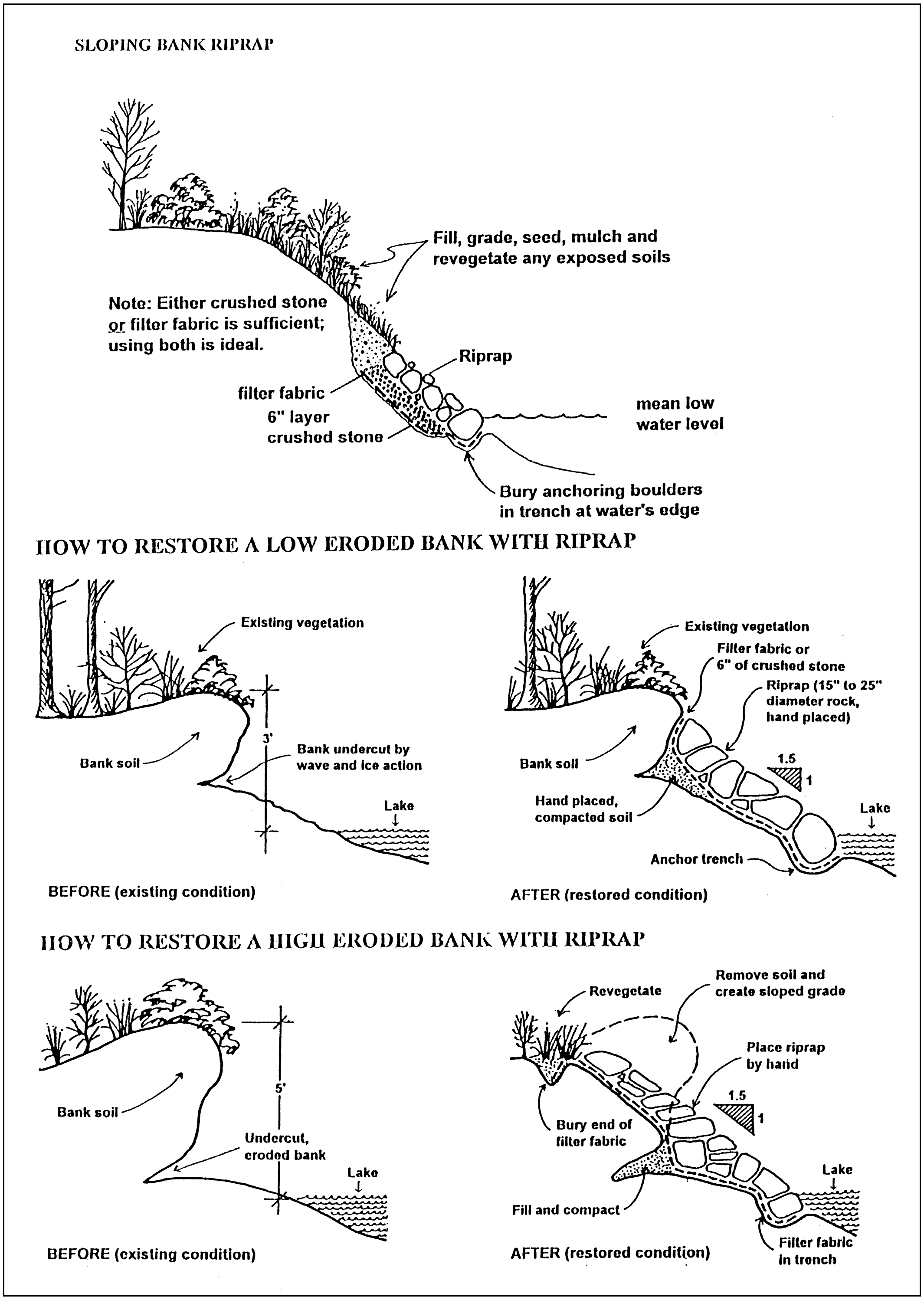


FIGURE 5. RIPRAP SLOPE

CULVERT INLET AND OUTLET PROTECTION

Culvert Inlet Protection

Different types of material should be used for inlet protection, depending upon the velocity of the water entering and leaving the pipe. Vegetation can be used where velocities are slow. A riprap or stone lining must be used with swifter moving water. The fastest waters need solid armoring such as concrete headwalls. Proper design of culvert inlet protection requires a knowledge of hydraulics and other design specific topics. Please consult a professional for help. More details on this topic can be found in *Maine Erosion Control Handbook for Construction: Best Management Practices*, available from the DEP.

Vegetative Protective Measures: Vegetation should be installed according to the standards of the permanent grass BMPs (see p.2). All newly seeded areas must be mulched, and the mulch must be anchored with netting or matting. On gravel and clay embankments, the slope must be flatter than 2:1, and the conduit should extend beyond the fill by at least ½ the pipe diameter on both sides and the top. On sand and silt embankments, the slope must be flatter than 2½:1, and the conduit should extend beyond the fill by at least one pipe diameter on both sides and the top.

Flexible Protective Measures: Riprap should be installed that has the ability to withstand the maximum velocity of flow that the approach channel is designed for. Flexible liners such as rock riprap and gabions should be underlain by a gravel filter and appropriate geotextile material to protect from piping. Light weight liners should be attached to the embankment with durable pins spaced closely enough to withstand the expected flow turbulence.

Structural or Rigid Protection: Structural or rigid inlet works should extend at least one pipe diameter beyond the culvert. Rigid inlet retaining walls should be reinforced enough to withstand settling, frost heaving, and other associated loadings without cracking or failing.

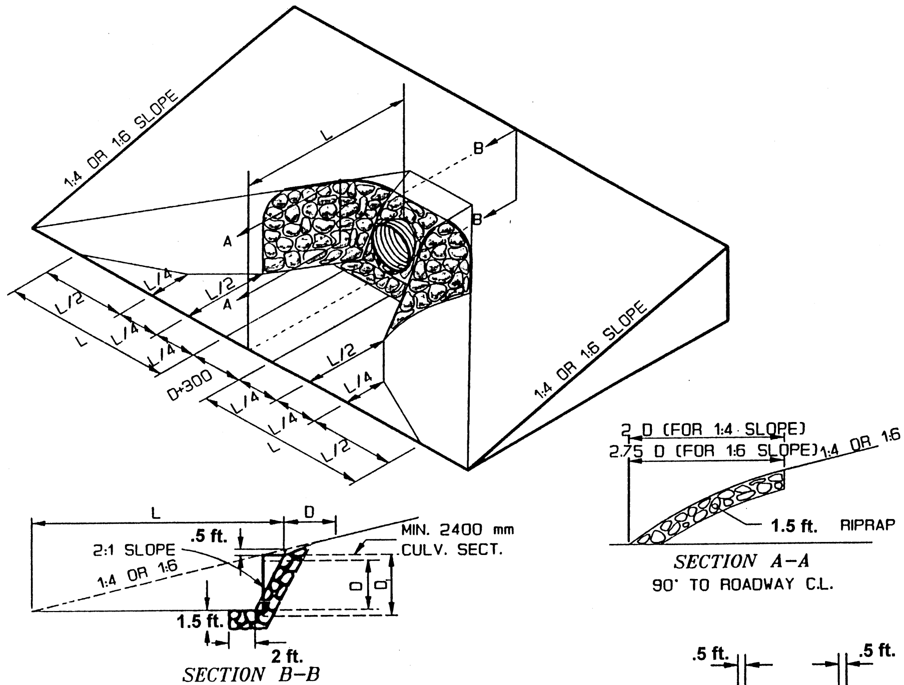
Culvert Outlet Protection

The outlets of pipes and structurally lined channels are areas where there's a high potential for erosion. Stormwater transported through man-made conveyance systems at design capacity often reaches a velocity which causes erosion in the ditch area. To prevent scour, a flow transition structure is needed to absorb the initial impact of the flow and to slow it. Outlet protection should be installed and stabilized prior to directing runoff from the pipe or culvert.

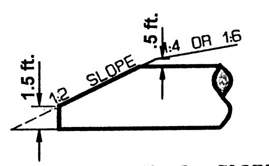
There are a number of different outlet protection designs. The two most common of these are outlet aprons and plunge pools.

Outlet Apron: An outlet apron is designed to allow flow to spread out so that the flow off the apron is slow enough so as to not cause erosion. These aprons are generally lined with riprap, grouted riprap or concrete. They are constructed so that they are level for a distance related to the outlet flow rate and the tail water level. The depth of tail water immediately below the pipe outlet must be determined for the design capacity of the pipe. Pipes which outlet onto the areas with no defined channel may be assumed to have a minimum tail water depth. If the pipe discharges directly into a well-defined channel, the apron should extend across the channel bottom and up the channel banks to an elevation of one foot above the maximum tail water depth or to the top of the bank, whichever is less. The side slopes of the channel should not be steeper than 2:1. Finally, the apron should be situated so that there are no bends in the horizontal alignment.

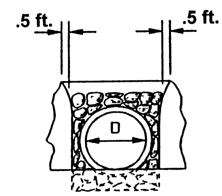
Stilling Basins and Plunge Pools: Where flow is excessive for the economical use of an apron, excavated stilling basins or plunge pools may be used. Plunge pools allow for the dissipation of energy by dropping the flowing water into a pool. An outlet pool lined with 6- to 12-inch stone constructed one diameter deep, two diameters wide and four diameters long will provide adequate



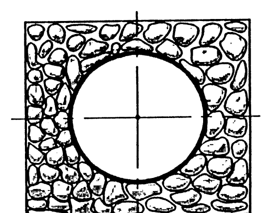
CULVERT DIAMETER	L 1:4 SLOPE	L 1:6 SLOPE
1.5 ft	9 ft.	12.8 ft.
1.7 ft.	9.8 ft.	14.7 ft.
2 ft.	10.8 ft.	16.4 ft.
2.5 ft.	12.8 ft.	19.7 ft.
3 ft.	15 ft.	22.6 ft.
3.4 ft.	17 ft.	25.6 ft.
4 ft.	19 ft.	29 ft.
4.4 ft.	22 ft.	32 ft.
5 ft.	24 ft.	35.4 ft.
5.4 ft.	26 ft.	38.7 ft.
6 ft.	28.5 ft.	42 ft.
7 ft.	32.5ft.	48.2 ft.



CULVERTS CUT ON 1:2 SLOPE



FRONT VIEW



INSTALL RIPRAP 2 ft. AROUND DIAMETER OF PIPE ON 1:2 GUARD RAIL SLOPES.

1. THE DIMENSIONS SHOWN ARE APPROXIMATES AND MAY BE MODIFIED BY THE RESIDENT ENGINEER.
2. RIPRAP WILL BE REQUIRED ON PORTIONS OF THE CULVERT END TREATMENT 1:1 AND STEEPER. THE REMAINING PORTION SHALL OR LOAMED, SEEDED AND HAY MULCHED AS DIRECTED BY THE ENGINEER.
3. CULVERTS INSTALLED ON 1:2 SLOPES SHALL HAVE RIPRAP LAID ON 1:2 SLOPE AROUND THE INLET AND OUTLET.

FIGURE 7. CULVERT INLET

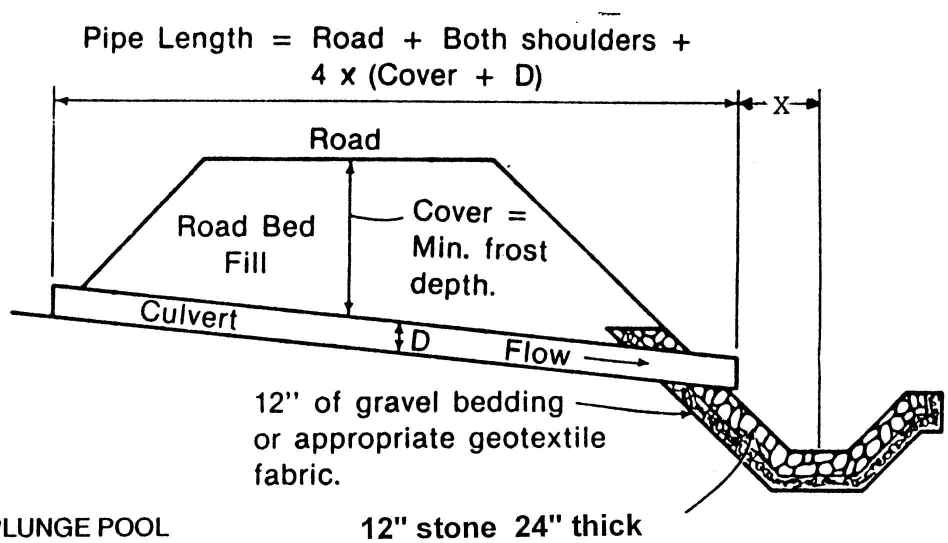
outlet protection for a culvert with a 36 inch diameter or less. Culverts greater than 36 inches should be designed by a professional engineer.

Hanging culverts: 'Hanging' culverts (culverts with a significant drop from the outlet to the stream) with plunge pools are illegal on streams with migrating fish, as these prevent fish passage altogether. The need to maintain adequate base flow in streams to allow fish passage must be incorporated into the design of the culvert outlet where appropriate. The Maine Department of Inland Fisheries and Wildlife is concerned about some streams where aprons can be so wide that the depth of water from the base flow of the stream is too shallow to allow fish passage. Consult with the Department of Inland Fisheries and Wildlife for further guidance.

MAINTENANCE

Periodically check all aprons, paved channel outlets, plunge pools and structural outlets for damage, and repair them as needed. If any evidence of erosion or scouring is apparent, modify the design to provide long term protection (keeping in mind fish passage requirements, if applicable).

DETAIL OF CULVERT OUTLET PROTECTION (full flow non-pressure)



PLUNGE POOL
1 D deep
2 D side
4 D long

PIPE SIZE (inches)	X (feet)
12"	2 ft
18"	3 ft
24"	5 ft
36	7 ft

FIGURE 8. CULVERT OUTLET

DITCH TURNOUTS

A ditch turnout consists of a stable ditch, a turnout berm, and a trench outlet used to store and release road runoff into an existing, stable, vegetated buffer area. The outlet is constructed across the slope and is lined with a combination of stone and existing natural vegetation which disperses, filters and spreads the concentrated flow thinly over a receiving area. An additional benefit of a ditch turnout is to remove, to some degree, sediment and other pollutants from runoff by filtration, infiltration, absorption, adsorption, decomposition, and volatilization.

Mostly seen when treating short segments of roads, ditch turnouts can also be used below developed sites where it is desirable or necessary to disperse concentrated water into buffers adjacent to coastal areas. This BMP is restricted to drainage areas no larger than 2 acres.

Ditch turnouts should be installed at the same time the ditch is constructed. Once soil is exposed, the turnouts should be constructed immediately and stabilized. Plan the construction of the ditch and turnout so that the vegetation in the receiving and filter areas remains undisturbed. Small disturbed areas should be stabilized with vegetation.

Locating a Ditch Turnout

Ditch turnouts must be carefully located to divert water into well-vegetated woods or a buffer strip. When properly installed, water from the turnout should sheet flow through the woods or buffer (a thin film of water about ½ an inch deep at the most).

Ditch turnouts that treat road runoff should only be located within a buffer if they handle small volumes of less than 1.0 cubic foot of flow per second.

Runoff from the uphill side slopes of the road should not be allowed to drain into a turnout.

Before diverting water onto someone else's property, you must get the owner's permission. Sometimes ditch turnouts can be readily located along lot lines between properties.

Remember! Water should never be directed toward a septic system or leach field.

Design

Ditch turnouts should blend smoothly into the downstream receiving area without any sharp drops or irregularities, to avoid channeling the water. In the receiving area, evaluate the existing slopes and soil material, vegetative species and their condition, and the time of year available for proper establishment of vegetation prior to construction of the ditch and turnout berm. If grass cover needs to be installed in the ditch and/or the receiving area, the timing of the construction will be limited by the growing season. Final seeding should be completed by September 1.

The receiving area should be flat enough to prevent the flow from channeling before it enters a stable watercourse. If the receiving area is not stable before construction begins, stabilize it before the ditch turnout is built (this will limit construction to the growing season).

The ditch and turnout berm must be stabilized with either vegetation or a suitable structural lining such as riprap. The side slopes of the berm should be a maximum of 2:1. The minimum height should be 2 feet. Trenches should be constructed along the existing contour and should be 15-20 feet long, at least 7 feet wide across the top, and at least 2 feet deep. The trench should be filled with 4-6 inches of clean stone.

The spacing between ditch turnouts is based on the road grade, as shown below, or through calculations.

Road Grade	Spacing between Turnouts
1-2%	200 feet
3-10%	150 feet
10%+	100 feet

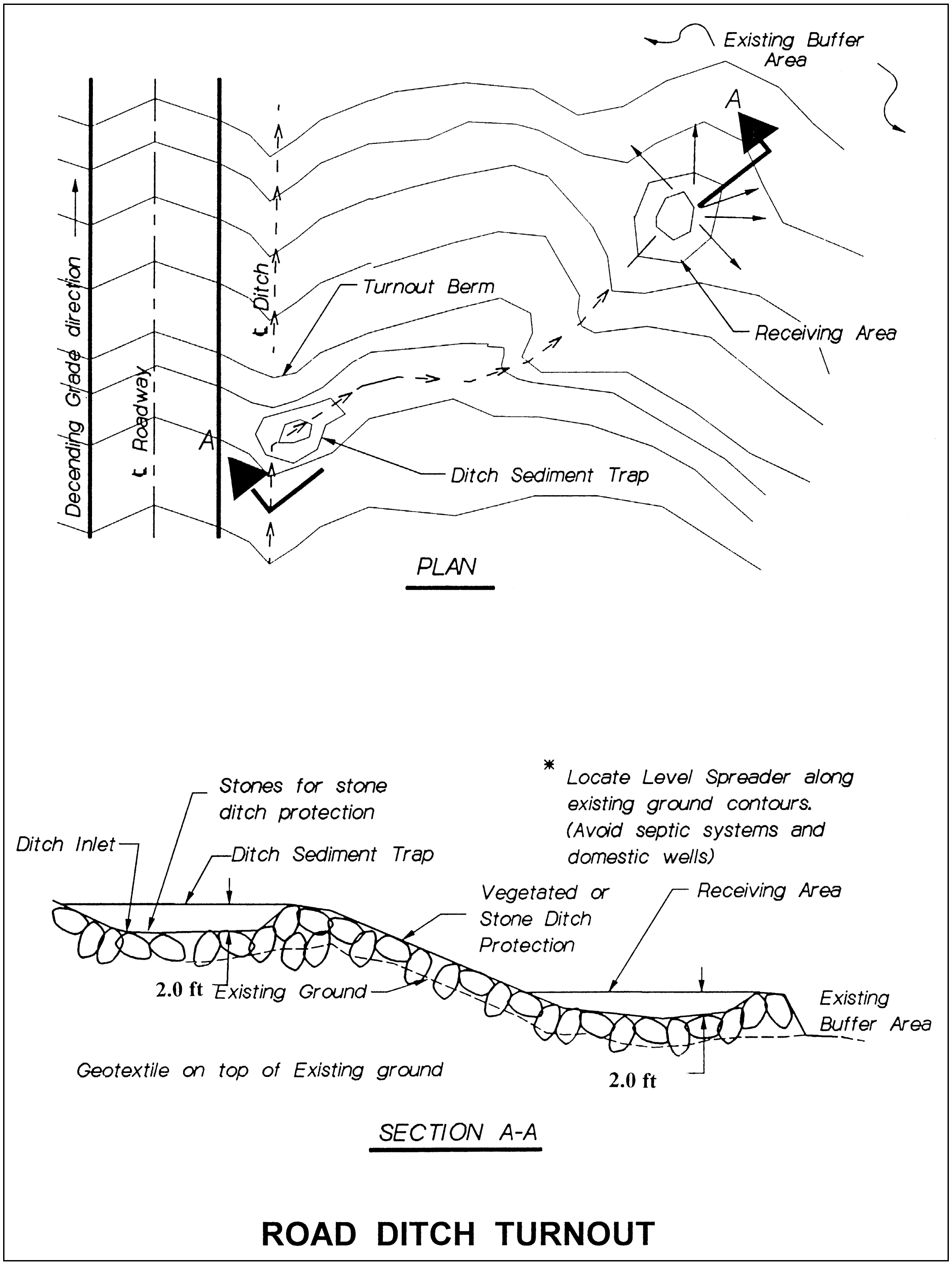


FIGURE. 9. DITCH TURNOUT

Maintenance

After construction, ditch turnouts need to be carefully inspected for any signs of channeling and immediately repaired. It will be necessary to remove sediment from the ditch turnout trench when the structure is no longer distributing the runoff uniformly across the trench.

LEVEL SPREADERS

A level spreader is an outlet constructed at zero grade across a slope. It consists of a vegetated or mechanical structure used to disperse or spread concentrated flow thinly over a well vegetated receiving area or buffer. Level spreaders reduce erosion and the movement of sediment, and also filter sediment, soluble pollutants, and sediment-attached pollutants.

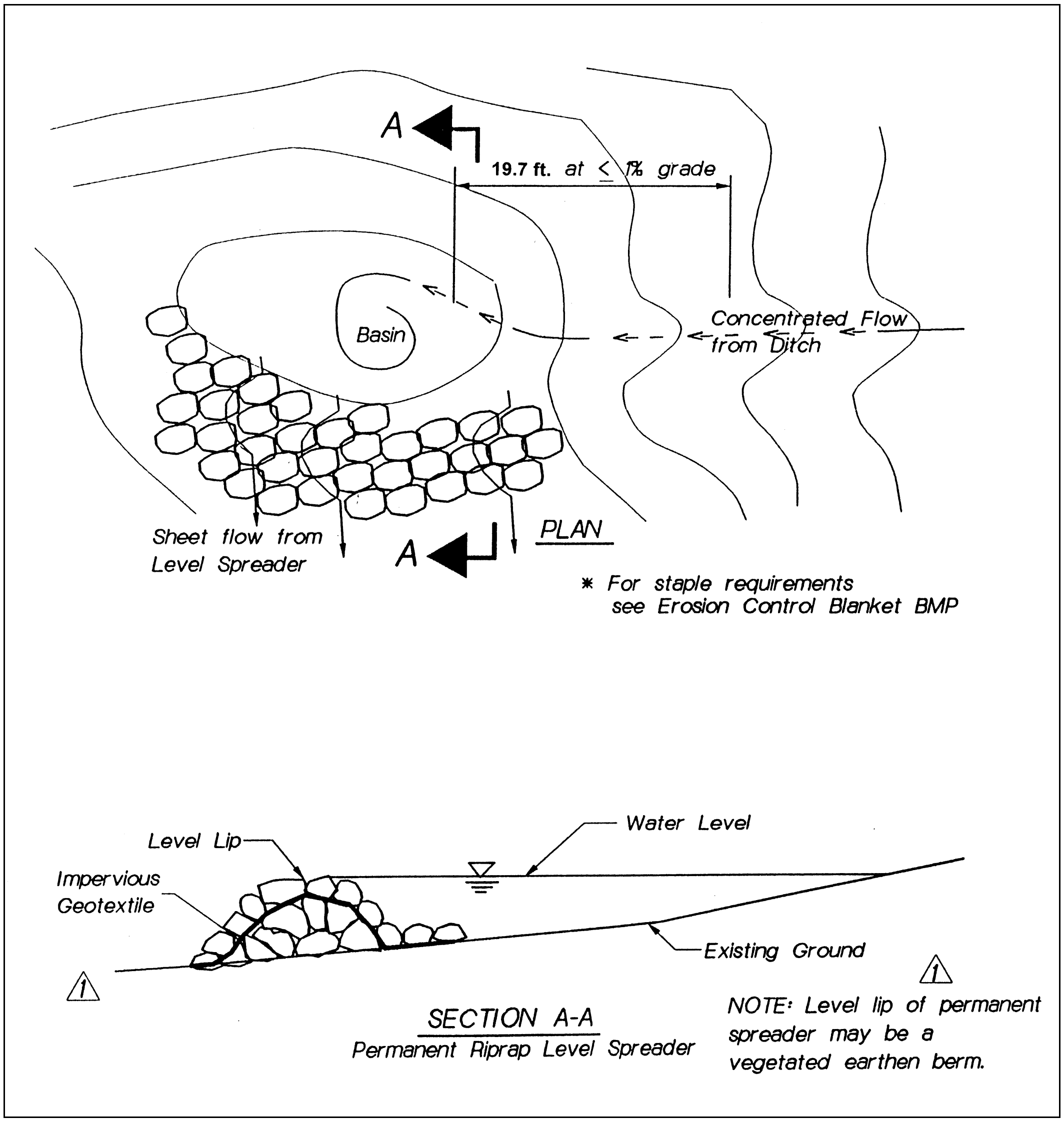


FIGURE 10. LEVEL SPREADER

Without an easement, level spreaders should not be used where flows will cross adjoining properties. Flows should be intercepted by stable drainageways that can handle the additional water, and the receiving area must be as flat in cross section as possible to ensure uniform distribution of the flow. Otherwise, the water will channel. Level spreaders should be constructed on undisturbed soil where possible.

Design Criteria

The capacity of each level spreader should be based on the allowable velocity of the water flow, given the soil conditions. The minimum length should be 12 feet.

The receiving area below the level spreader should be protected from harm during construction. Small disturbed areas should be stabilized by sodding and/or netting in combination with vegetation BMP requirements. The receiving area should not be used by the level spreader until it has been stabilized. A temporary diversion may be necessary.

Level spreaders should blend smoothly into the downstream receiving area without any sharp drops or irregularities in order to avoid channeling, turbulence, and hydraulic jumps.

Maintenance

After construction, level spreaders need to be carefully inspected for any signs of channeling and immediately repaired. The structure will fail if water exits from it in channeled flow. Vegetated level spreaders may require periodic mowing.

CONSTRUCTION BMPS

Erosion and sedimentation are more likely to occur during construction projects because of the soil disturbance the construction causes. When construction occurs at a marina or boatyard – close to the water's edge – it is even more important to use Best Management Practices that will prevent or lessen polluted runoff.

Before Construction of any New Facility

Determine if the soils on your site are really suited for the proposed use. Avoid disturbing wet areas, steep slopes, drainageways, unstable soils, areas subject to flooding, stream banks or edges, and lake shores.

Become familiar with the natural drainage patterns of the property and try to avoid altering them. Proper site design will help you avoid expensive erosion control measures.

Contact your town office or code enforcement officer for any necessary permits or applications. Contact the Maine DEP for projects within 100 feet of a water body or wetland. If your property is in an unorganized territory, contact the Land Use Regulation Commission (LURC).

Minimize clearing and plan to preserve existing vegetation as much as possible. Vegetation will naturally curb erosion, improve the appearance and the value of your property, and reduce the cost of landscaping later. Wide buffer strips of undisturbed vegetation are required along stream and lake shores. Don't allow heavy machinery to operate in these buffer areas.

Discuss clearing limits with your contractor in advance. Field mark these limits with ribbons or flagging. Flag trees and shrubs that you want protected. Remember that heavy machinery must be kept well away from trees to avoid compacting their roots; otherwise, they will die a few years later. Tree roots can also be smothered if excess fill is re-graded around them.

Plan earth moving activities early enough in the year so that you can re-vegetate the site by September 15th. Plan to mulch disturbed areas over winter if construction is delayed past September 15th. This will protect bare soil from spring runoff.

Machinery must not be allowed to cross streams. Major damage to stream banks occurs when heavy equipment is carelessly run in stream channels. If access across a stream is needed, plan for a temporary culvert and stream crossing that can be removed later.

Winter construction (November 15 to May 15) should not be undertaken unless supervised by a professional.

During any Construction

Before doing anything else, install a filter barrier on the downslope side of the construction area. This barrier can be either a silt fence, an embedded hay bale barrier, or a combination of the two. A silt fence is better at filtering out soil from water, but is easily pushed over by construction equipment. Hay bales don't filter dirty water as well, but are more rugged in the field. When working in a critical area (next to water bodies) use them both. REMEMBER! Hay bales and silt fencing don't work unless they are installed and maintained properly.

If possible, when earth moving, stockpile the topsoil separately so it can be spread back on top of the site. You'll have greater success in establishing a new lawn or buffer strip area as a result. Ring the downslope edge of topsoil stockpiles with silt fencing or embedded hay bales.

Use mulch hay liberally on disturbed soil during the construction period to avoid having an erosion problem. Mulch hay is the cheapest and most effective way of protecting the soil. Don't let a week pass without mulching!

Culverts should be used where a driveway enters a main road. The minimum size should be 12 inches in diameter. A "rule of thumb" for estimating culvert size for watersheds smaller than 7 acres is to add 8 to the number of acres in the watershed to determine the culvert diameter. For example, a 7-acre watershed + 8 = a 15" diameter culvert. Larger culverts should be designed by a professional engineer. Generally, the entrance and exit areas of a culvert should be reinforced by stone (riprap).

Grassed ditches or waterways can be used to channel moderate water flows. Be sure to line the base of new channels with erosion control mats or use a combination of mulch and biodegradable netting to hold the soil until grass is established. Contact an engineer for ditches on steep slopes (greater than 5%) or ditches that will carry a steady flow of water.

Use diversions to take water across a slope and away from a critical area. A ridge or berm should be constructed on the low side to carry the water.

Structures such as stone (riprap) channels, catch basins, or pipe systems are used to carry large, concentrated flows down a steep slope. These should be designed by an engineer.

Cut and fill slopes should be no steeper than 2:1 (2 feet of horizontal run for every foot of vertical rise) if vegetation will be used to stabilize them. Steeper slopes generally will need riprap or other structural modifications. If a lot of water comes down the slope you may also need riprap. Consult an engineer in these cases.

After Construction

When the earthmoving is completed, replant the area. Don't automatically plant the area to grass – consider replacing the native trees and shrubs. These species are generally better at taking up the pollutants and nutrients in runoff.

Be extremely careful when using fertilizers near streams, lakes and ponds. Don't apply them before a storm. Use mixes that are very low in phosphorus in these areas.

Check to see that your silt fencing and hay bales are in good condition before a storm. Check and repair them again after storms. Remove sediment that has accumulated. Replace silt fencing that no longer allows water to filter through it. If the barriers are being undercut at the edges, they should be replaced by a stone checkdam.